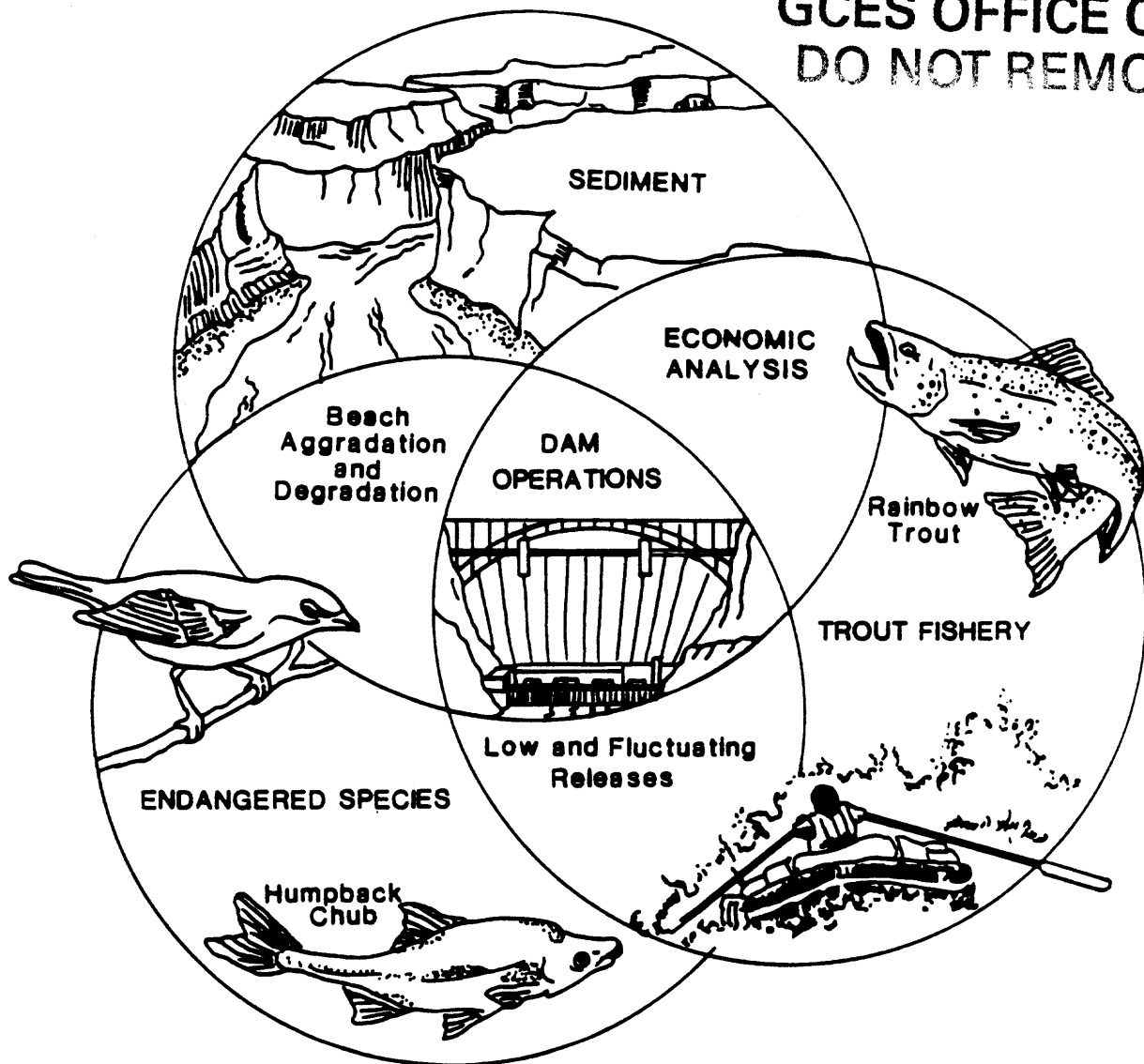


GLEN CANYON DAM

MONITORING OF INTERIM OPERATING CRITERIA

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MARCH 1993 - MAY 1993

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GLEN CANYON DAM
MONITORING
OF
INTERIM OPERATING CRITERIA

March 1993 through May 1993

Bureau of Reclamation

This document summarizes the monitoring of Interim Operating Criteria for Glen Canyon Dam from March 1993 through May 1993. This is the fifth report of monitoring of operating criteria, with the first report covering August through December 1991, the second report covering January through April 1992, the third report covering May through September 1992, and the fourth report covering October 1992 through February 1993. Summaries will be published periodically throughout the interim operation period.

BACKGROUND

The Glen Canyon Dam Interim Operating Criteria were implemented on November 1, 1991, following a 3-month testing of the proposed interim flow criteria. An Environmental Assessment was completed in October 1991 with a Finding of No Significant Impact. The Interim Operating Criteria will remain in effect until completion of the Glen Canyon Dam Environmental Impact Statement, scheduled for completion in October 1994, and Record of Decision scheduled shortly thereafter.

Exception Criteria. The Western Area Power Administration and the Bureau of Reclamation signed an interagency agreement on October 21, 1991, implementing exception and associated interim operating criteria, including financial exception criteria.

The exception criteria allow deviation from the interim flow criteria for response to power system disturbances or other emergency situations and for power system regulation. The agreement incorporates emergency and system regulation provisions which were in place during research flows and, in addition, includes "financial criteria" as a means of avoiding the expense of purchasing replacement firm capacity and energy during the interim period. The financial criteria element is conditional. The primary conditions include:

- limiting the use of financial criteria to not more than 3 percent of the time (22 hours) in any consecutive 30-day period
- periodic review and renewal, and
- reporting the use and costs associated with the financial criteria

MONITORING OF INTERIM FLOW CRITERIA

The operating criteria parameters--maximum daily flows, minimum daily flows, daily fluctuation, and ramp rates--are monitored at the Glen Canyon Dam using Reclamation's Supervisory Control and Data Acquisition (SCADA) system. The discharge and river stage changes are monitored at downstream gaging stations near Lees Ferry and Grand Canyon Village. The SCADA data at Glen Canyon Dam is recorded in megawatts of energy and require conversion to flow--cubic feet per second (cfs).

From March 1, 1993, through May 31, 1993, the maximum flow of 20,000 cfs was adhered to as shown on the charts in Attachment A. The minimum flow of 5,000 cfs at night and 8,000 cfs between 7 am and 7 pm was also met throughout the period. The release volumes of the individual months were as follows:

March 1993	606,000 acre-feet
April 1993	590,000 acre-feet
May 1993	592,000 acre-feet

The above volumes limited the daily fluctuation to 6,000 cfs per day which was adhered to throughout the 3-month period.

Ramp Rates - Ramp rates may be exceeded under the criteria for system disturbances, regulation, and other emergency situations to allow for power system operation adjustments. The ramp rates were exceeded periodically as a result of system disturbances and regulation responses to power demands. The deviations that occurred were resolved within the hour that they occurred in. All deviations were reported to the Glen Canyon Environmental Studies (GCES) office and appropriate monitoring actions were initiated. The number of times ramp rates were exceeded has been consistently reduced as operators have become more experienced with projecting power system adjustments.

Attachment B shows the traces of discharge and river stages at Lees Ferry and Grand Canyon Village for March 1993 through May 1993.

MONITORING OF EXCEPTION CRITERIA

The exception criteria are monitored at Glen Canyon Dam using Reclamation's SCADA system. Several deviations from the interim flow criteria occurred, primarily due to electrical system emergencies caused by electrical transmission system and generation capability. None of the system deviations lasted longer than 1 hour (see Attachment B).

Deviations from the ramp rate criteria have occurred periodically, particularly when the dam is following the power load under system regulation and generally occurs during the upramp. Such deviations are allowed under the generator regulation exception criteria.

The estimated net expenses of interim operations are included in Appendix C. Summary of estimated costs by month is shown in the following tabulation:

<u>Month</u>	<u>Net Expense</u>
March 1993	\$344,101
April 1993	\$227,469
May 1993	\$311,296

To date, financial exception criteria have not been used.

INTERIM FLOW MONITORING PROGRAM - RESOURCES AND RESPONSES

The program focuses on the evaluation of critical resources and ecosystem processes relative to the interim flow regime to determine natural changes in the ecosystem, changes as a result of interim flows, and effects on power generation.

Resource Response - Resources included in the monitoring program and responses to interim flows to date are:

Sediment - The January and February high tributary flows resulted in silt and clay covering many of the sediment deposits below the Paria River. This resulted in the filling in of backwaters, added sediment to beach faces, and the covering of marshes. Aerial video records were collected as were remote camera shots. A beach survey trip and scaled aerial photography was collected over Memorial Day weekend (May 29-31). The aerial photographs have been used by the resource agencies to identify changes that have occurred both as a result of interim flows and as a result of the high spring runoff. The majority of the beaches are rapidly reassuming their pre-January angle of repose and the gained sediment is being reworked into the main channel.

Riparian Ecosystem - The increase in sediment has provided additional substrate for the riparian vegetation to colonize in the river corridor. It is too early to identify the specific impacts of the interim and high flows but initial indication is that the riparian community has maintained itself. Several riparian vegetation trips have been used to document changes that have occurred since the initiation of interim flows. It appears that vegetation is migrating from the 30,000 cfs level down to the new high water line of 20,000 cfs. This increase in vegetation is providing habitat for reptiles, insects, and amphibians.

Aquatic Ecosystem - Juvenile Humpback chub, Gila cypha, from the 1991 spawn continue to show up in the mainstem river below the Little Colorado River (LCR) tributary. During 1992, the LCR experienced high flows as a result of local precipitation during what turned out to be a very wet year in Arizona. There is little direct evidence to suggest that 1992 was a very good spawn. The factors that contributed to the reduced spawn are related to local flooding events in the LCR drainage during the spawning period.

The success of the 1993 year class appears to be very good. Adult humpback chub have made several spawning runs into the Little Colorado River during optimum

flow situations in the tributary. The resulting young-of-the-year remain in the Little Colorado River. Conditions were near perfect for growth and survival. Additional adults have been located around springs in the lower Grand Canyon as have young-of-the-year fish. The number of catfish at the mouth of the Little Colorado River have been high.

Natural spawning of Rainbow Trout, Onchorynchus mykiss, has also benefitted from the interim operations. This is due to maintaining water over the spawning bars and in the near shore habitat areas. Significant numbers of unstocked fry and fingerling fish have appeared in Lees Ferry samplings by the Arizona Game and Fish Department and GCES. Of the young of year fish collected recently, approximately 74% appear to be naturally reproduced.

Cladophora clomerata and Gammarus lacustris (foodbase for the trout population) continue to reestablish in areas throughout the Lees Ferry reach. Blue green algae species have begun to be established in selected locations in the Canyon and in the Lee's Ferry areas have remained stable. Blue green algae do not support the extensive diatom food base that the green algae, Cladophora, does. Other aquatic macrophytes are beginning to gain footholds in the river and may perhaps be enhanced if the water warms.

Endangered Species - The interim flows have been designed to restrict fluctuating flow levels to enhance and maintain backwaters, side channels, and channel margin habitats. Interim flows have not been in effect long enough to document specific impacts, but monitoring continues.

A population of Kanab Amber Snails has been documented above the interim flow line at Vassey's Paradise. The impact of the interim flow levels on this population is thought to be minimal.

The population of Peregrine Falcons, Falco peregrinus, had a successful nesting season with dozens of adults setting up nests in the Grand Canyon. Several adults were observed teaching the young to hunt which is an indication that the season was a good one. The Peregrines are now the most common raptor in the Grand Canyon.

The winter use of the Nankoweap area of the Grand Canyon by the endangered Bald Eagle, Haliaeetus leucocephalus, was down from previous years due to low spawning of trout in Nankoweap Creek. Being very opportunistic feeders, the Bald Eagles quite likely dispersed to other areas in the Grand Canyon or to other locations in the Southwestern United States.

The use of the near shore riparian habitat by the Southwestern Willow Flycatcher, Empidonax trailli, was stable this year with 13 reported detections. Breeding groups were identified at Cardenas Marsh and at River Mile 50.5. The Cardenas Marsh group was a pair of birds while the group at River Mile 50.5 was one male and two females. Parasitism by the Brown-headed Cowbird, Molothrus ater, continues to limit successful recruitment of young birds to the population. Extensive habitat studies conducted utilizing Global Positioning Equipment are scheduled for the winter of 1993.

Cultural Resources - These resources, including Spencer Steamboat above Lees Ferry and Native American sites, are being monitored. The interim flows are designed to reduce sediment erosion at cultural resource sites. Continuous evaluations of the most sensitive locations are planned. The National Park Service has been documenting effects. Several Paiute and Zuni trips evaluated the cultural resources in the Grand Canyon and provided feedback to GCES and the National Park Service on key areas of concern.

Economic Resources - The past 6 months have had limited power emergencies. Much of the Western power grid has been at full operating levels resulting in substantial capacity and energy being available on the market and reduced strain on the Glen Canyon Dam electrical contractors.

Several deviations have occurred as related to power production in the Western grid and due to regulation at Glen Canyon Dam and short-term power emergencies. It is anticipated that the number of deviations will be reduced as the operators define their specific duties.

Recreation - Restricted fluctuations and higher minimum releases under the interim flows have provided safer passage for river trips through the Grand Canyon. Access to the Lees Ferry fishing area has been improved due to the higher minimum flow releases from Glen Canyon Dam. No extreme recreational impacts were reported due to flow levels.

Attachments

Attachment A - Glen Canyon Dam Releases

- Integrated Hourly Values - March 1993
- Hourly Ramping Rates (cfs/hour) - March 1993

- Integrated Hourly Values - April 1993
- Hourly Ramping Rates (cfs/hour) - April 1993

- Integrated Hourly Values - May 1993
- Hourly Ramping Rates (cfs/hour) - May 1993

Attachment B - Gaging Stations

- Lees Ferry - Flow Rate - March 1993
- Lees Ferry - Gage Height - March 1993

- Lees Ferry - Flow Rate - April 1993
- Lees Ferry - Gage Height - April 1993

- Lees Ferry - Flow Rate - May 1993

- Lees Ferry - Gage Height - May 1993

**Attachment C - Glen Canyon Dam Interim Operations - Western Area Power
Administration**

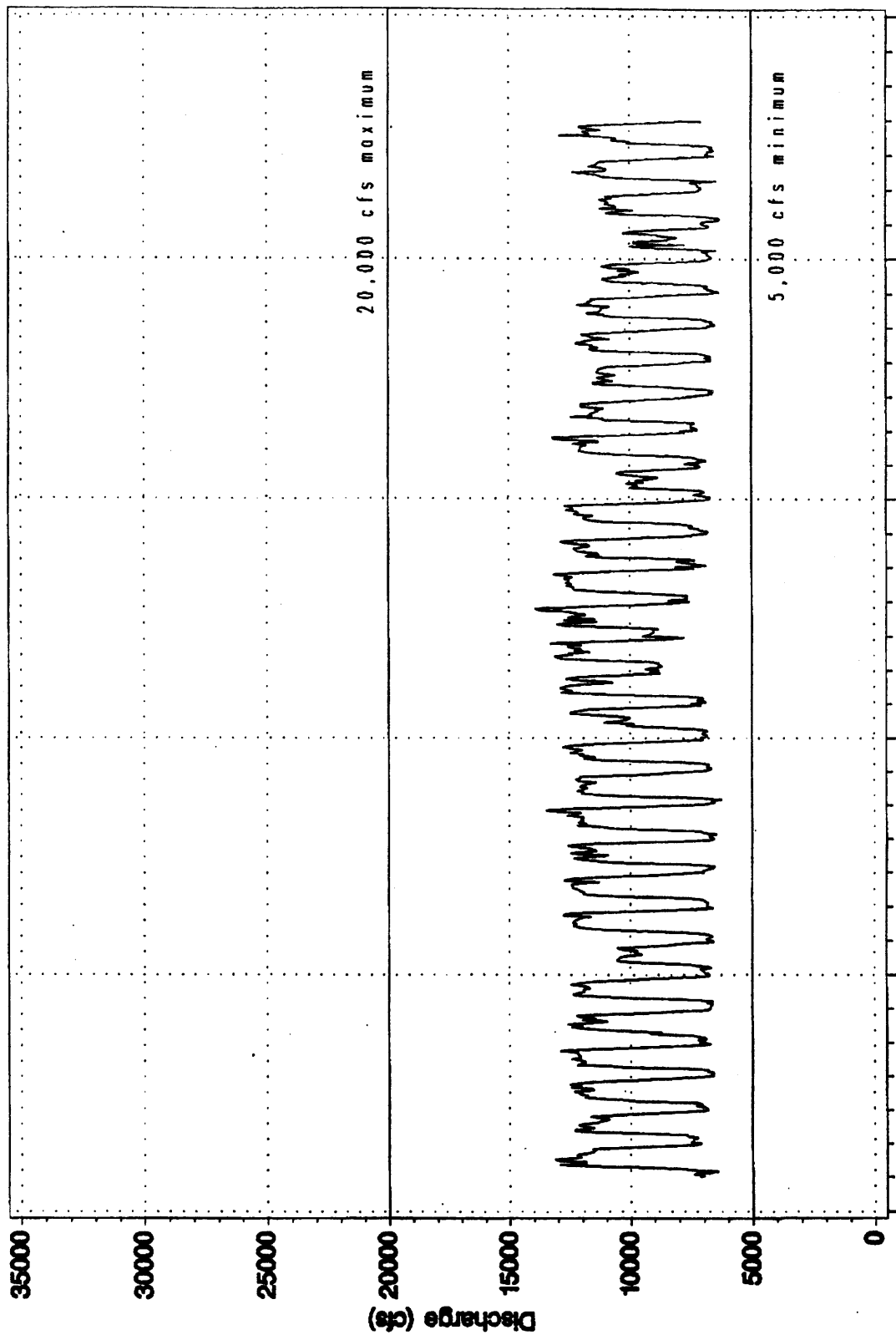
- March through May 1993

Attachment A

Glen Canyon Dam Releases

Glen Canyon Dam Releases

Integrated Hourly Values - March 1993



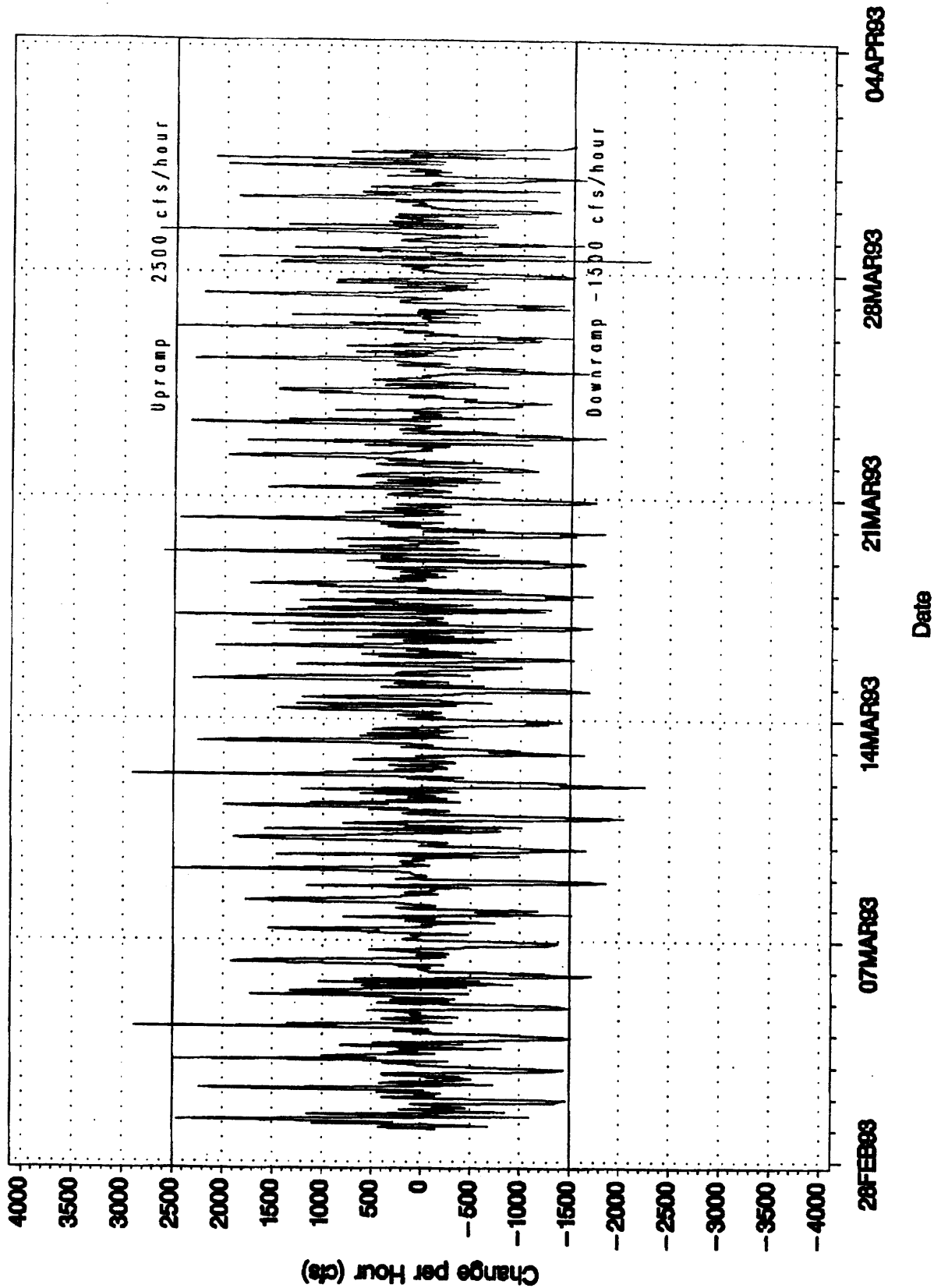
20,000 cfs maximum

5,000 cfs minimum

Date

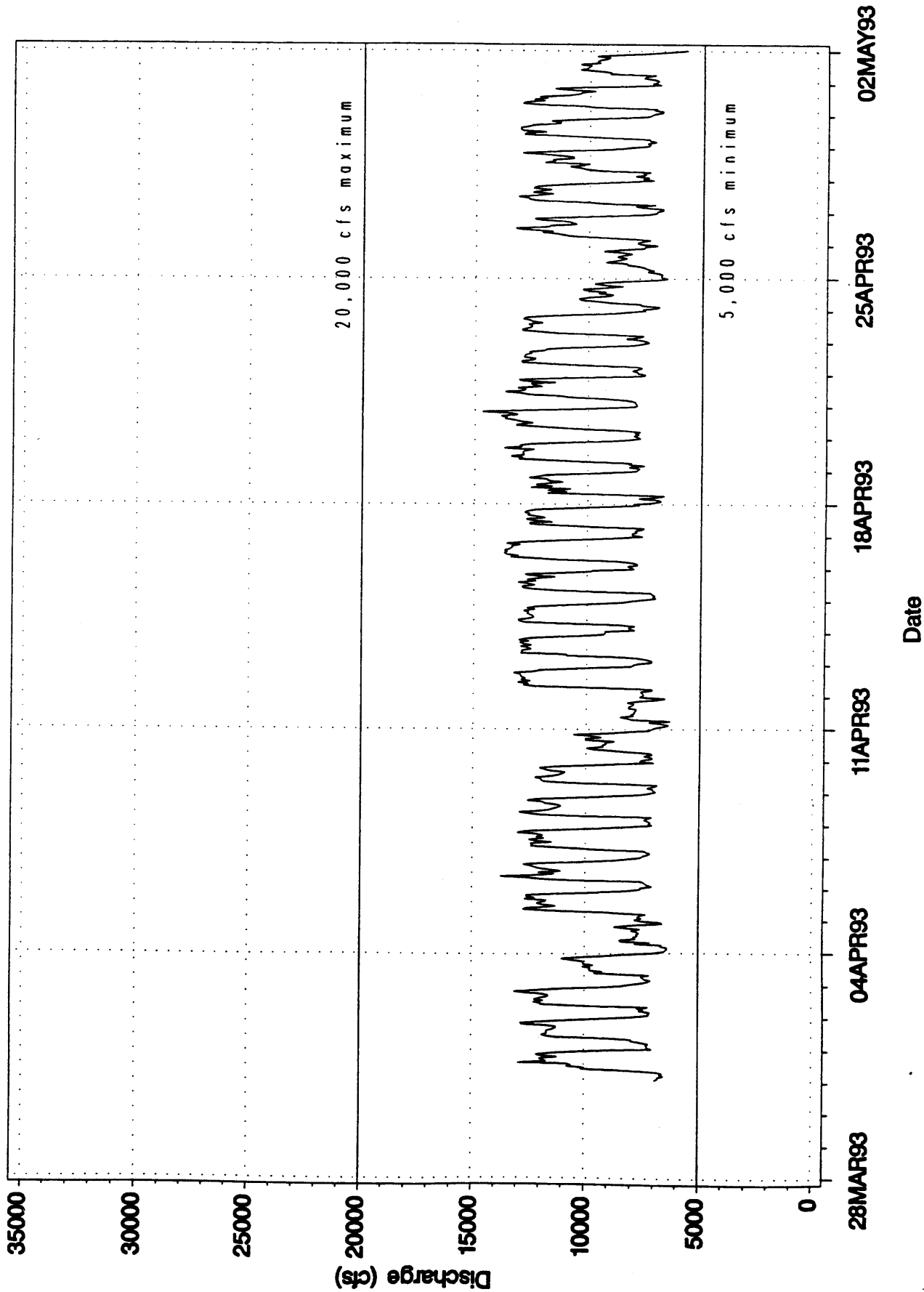
Glen Canyon Dam Releases

Hourly Ramping Rates (cfs/hour) - March 1993



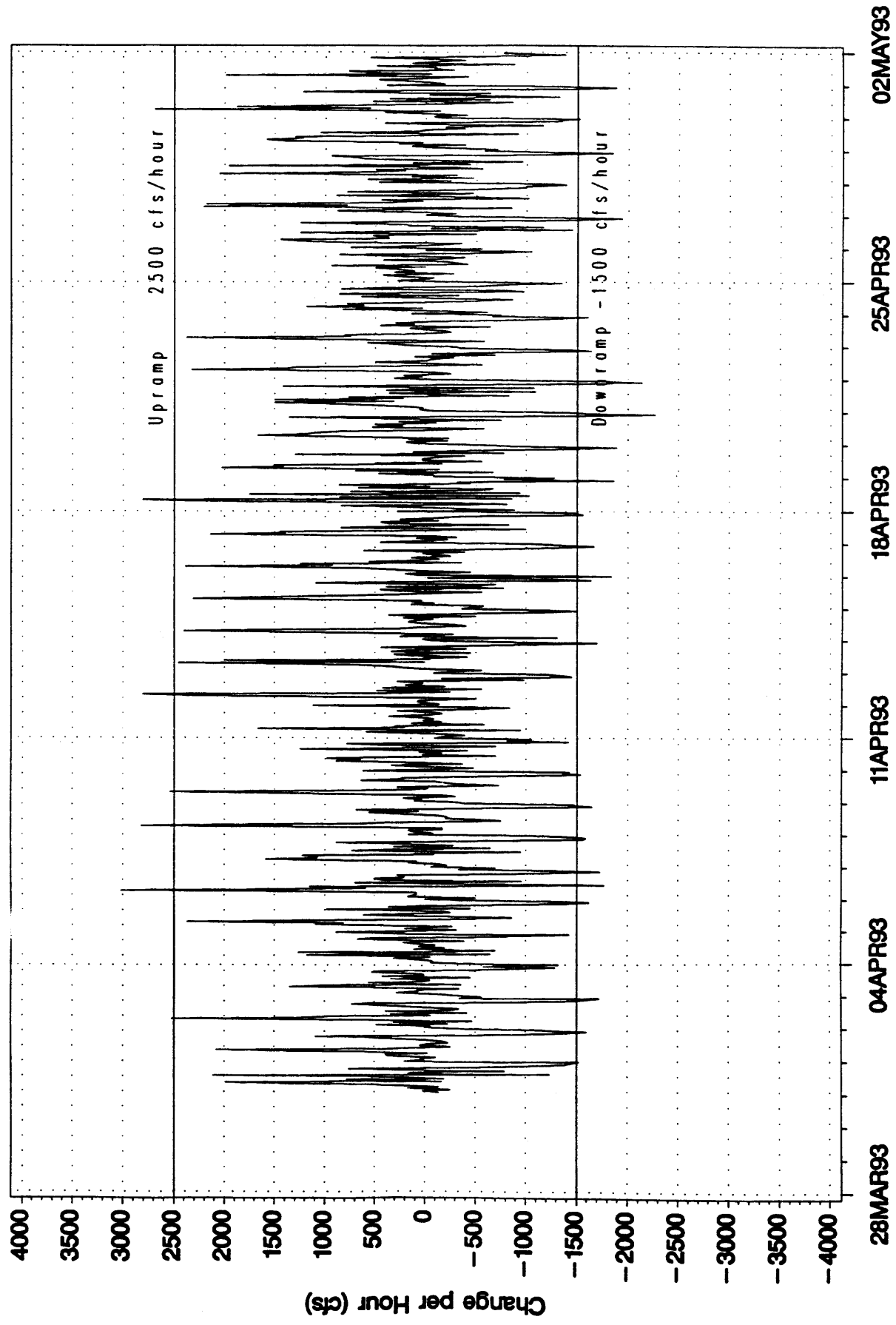
Glen Canyon Dam Releases

Integrated Hourly Values - APRIL 1993



Glen Canyon Dam Releases

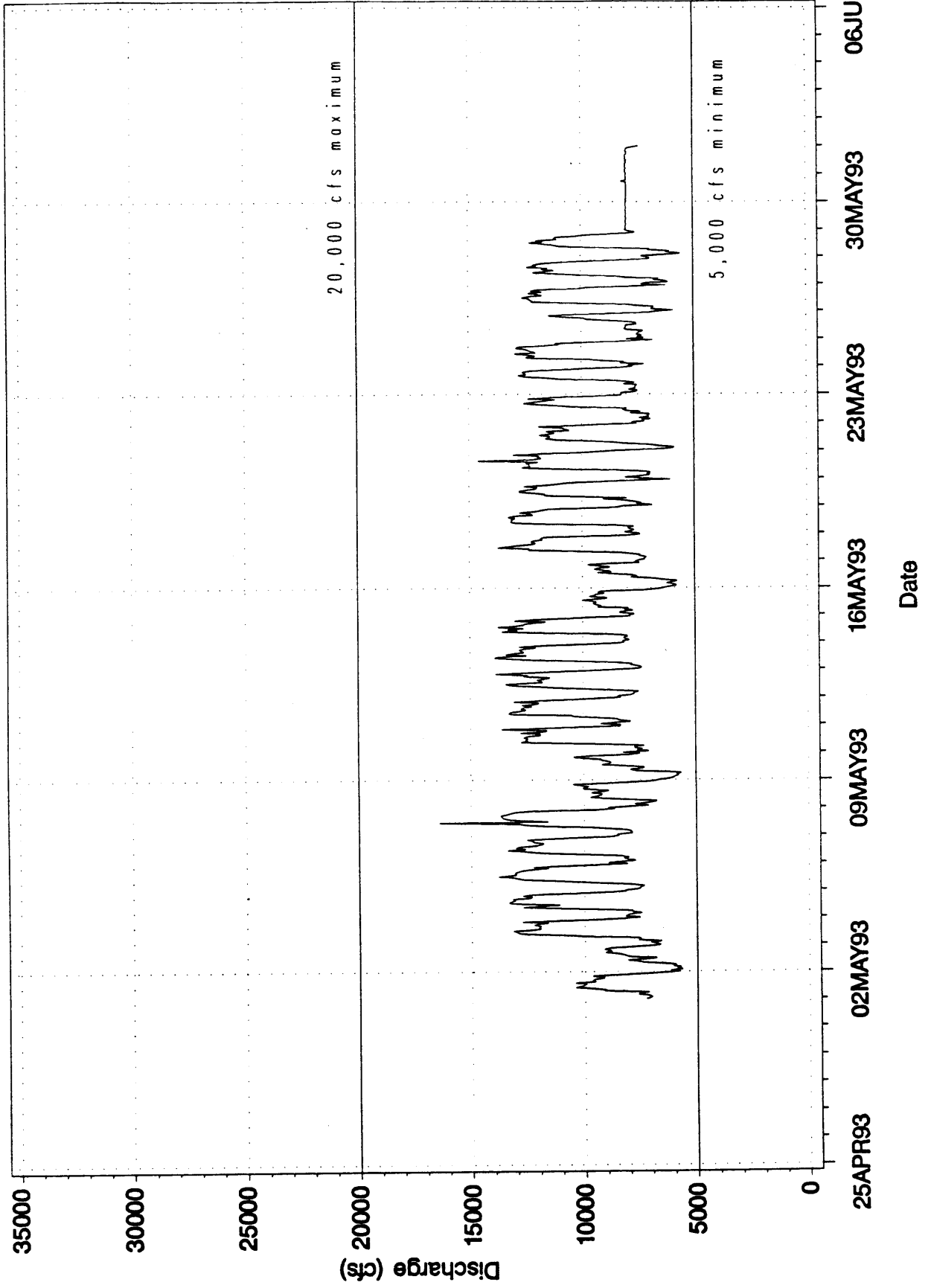
Hourly Ramping Rates (cfs/hour) - APRIL 1993



Glen Canyon Dam Powerplant Releases

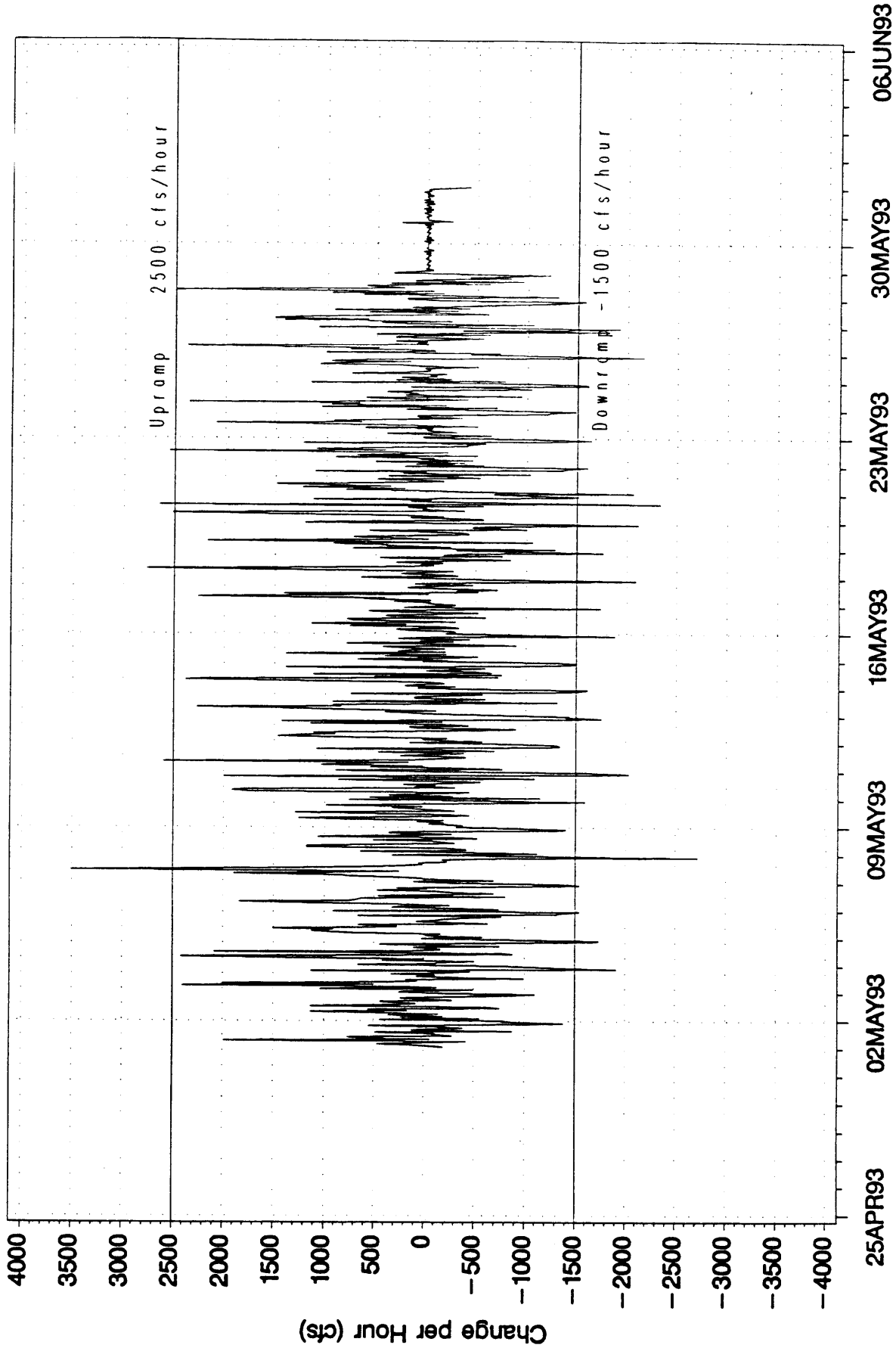
May 1993

Integrated Hourly Values



Glen Canyon Dam Powerplant Releases

May 1993
Hourly Ramping Rates (cfs/hour)

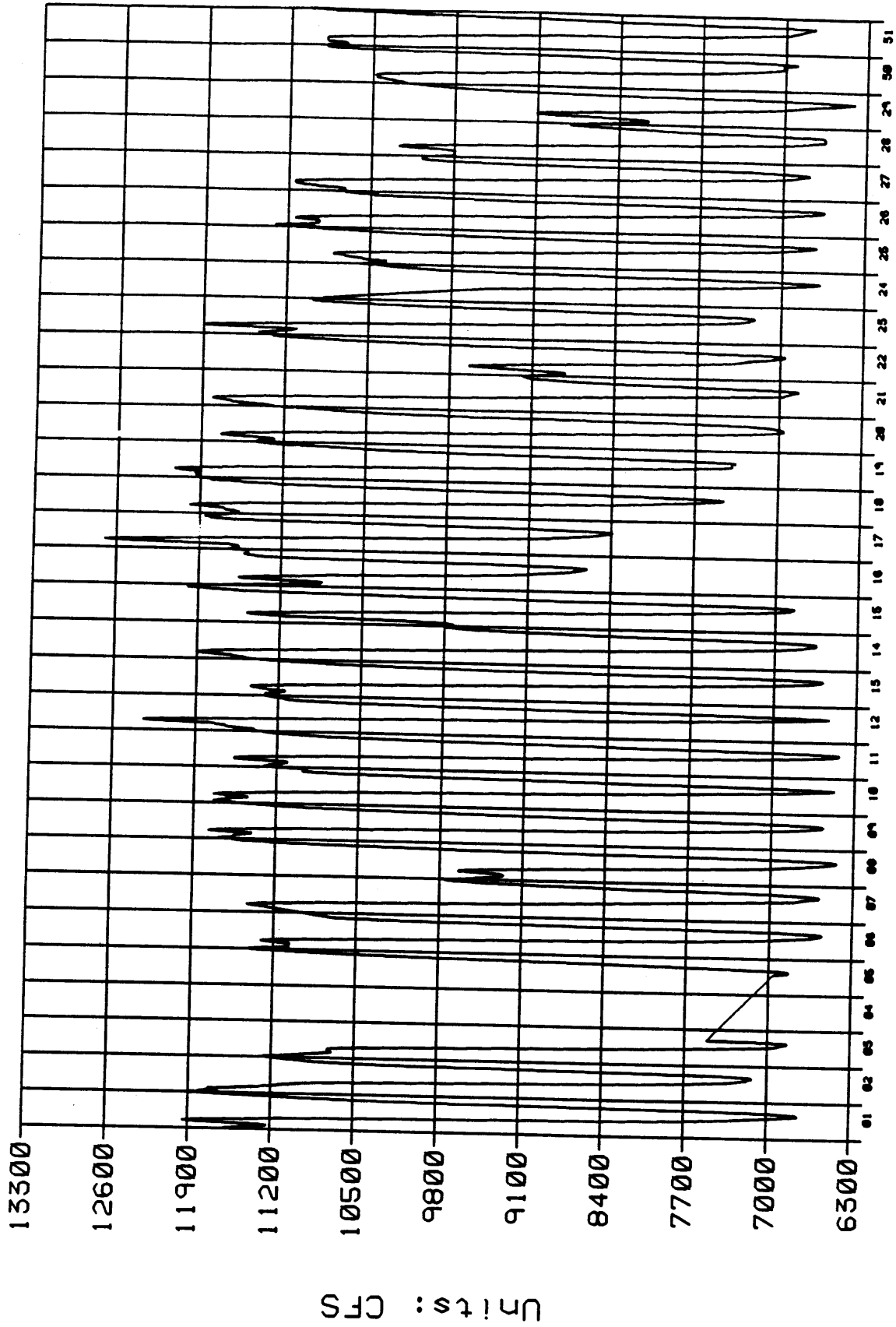


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Attachment B

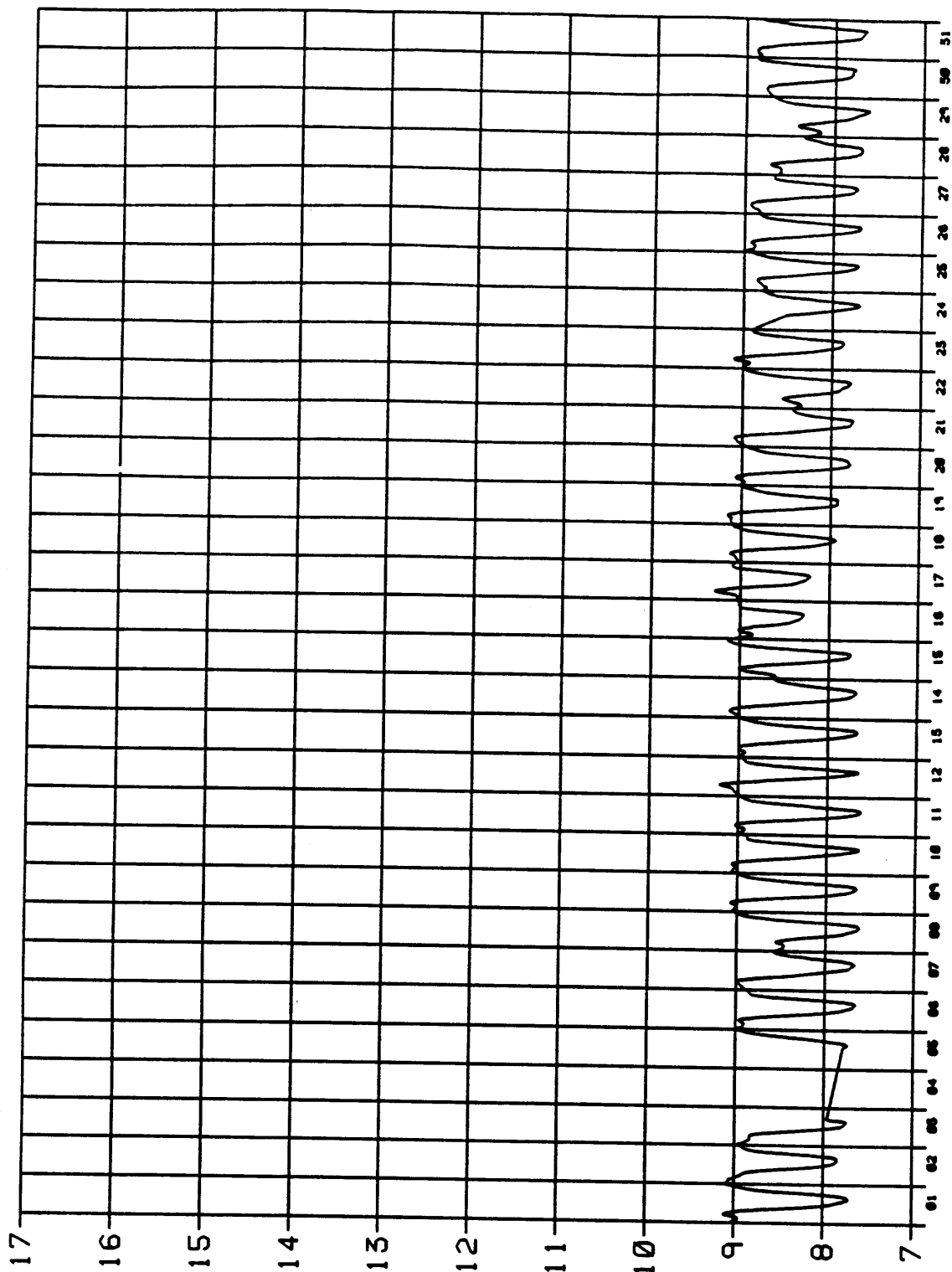
Gaging Stations

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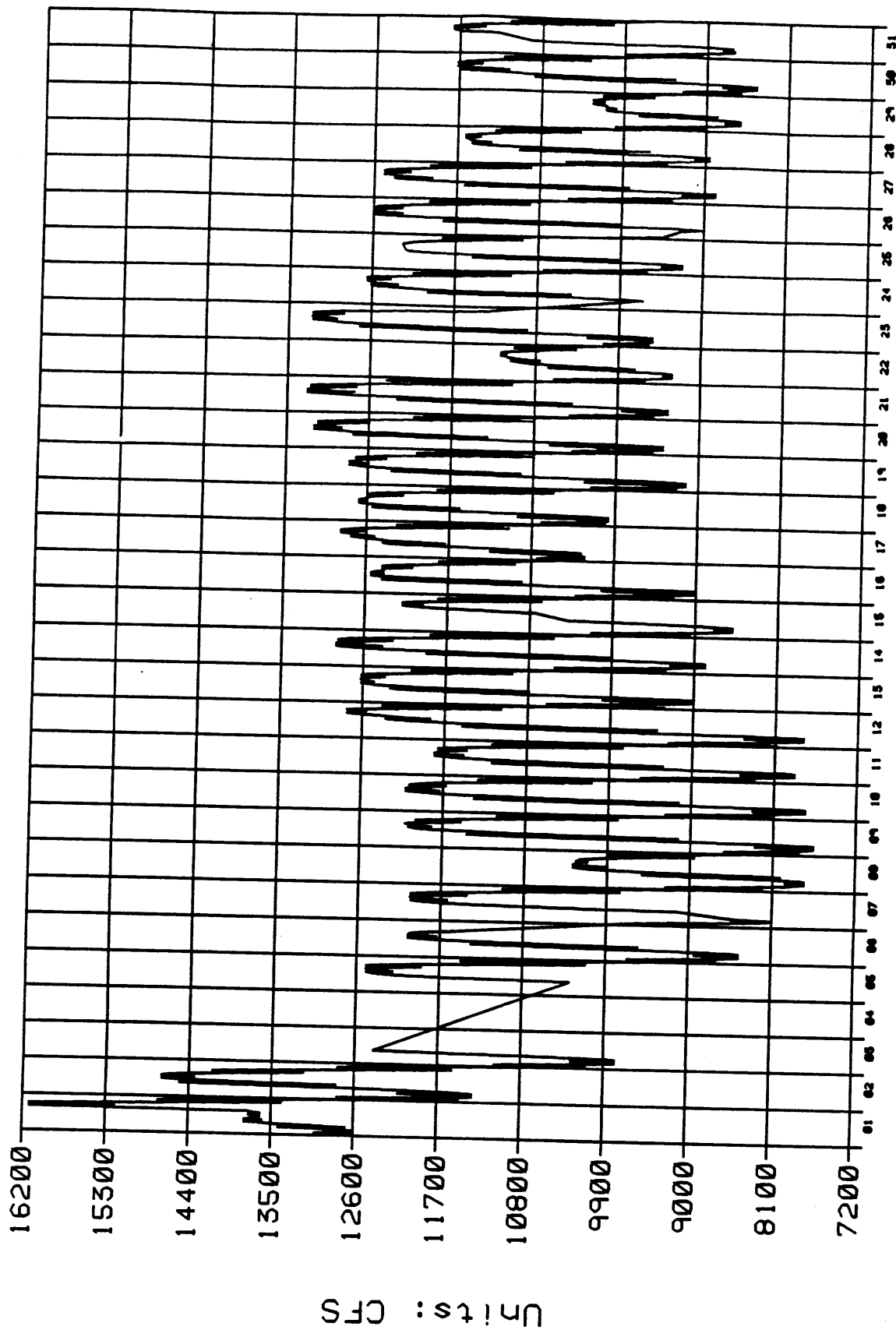
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Flow Rate (cfs)

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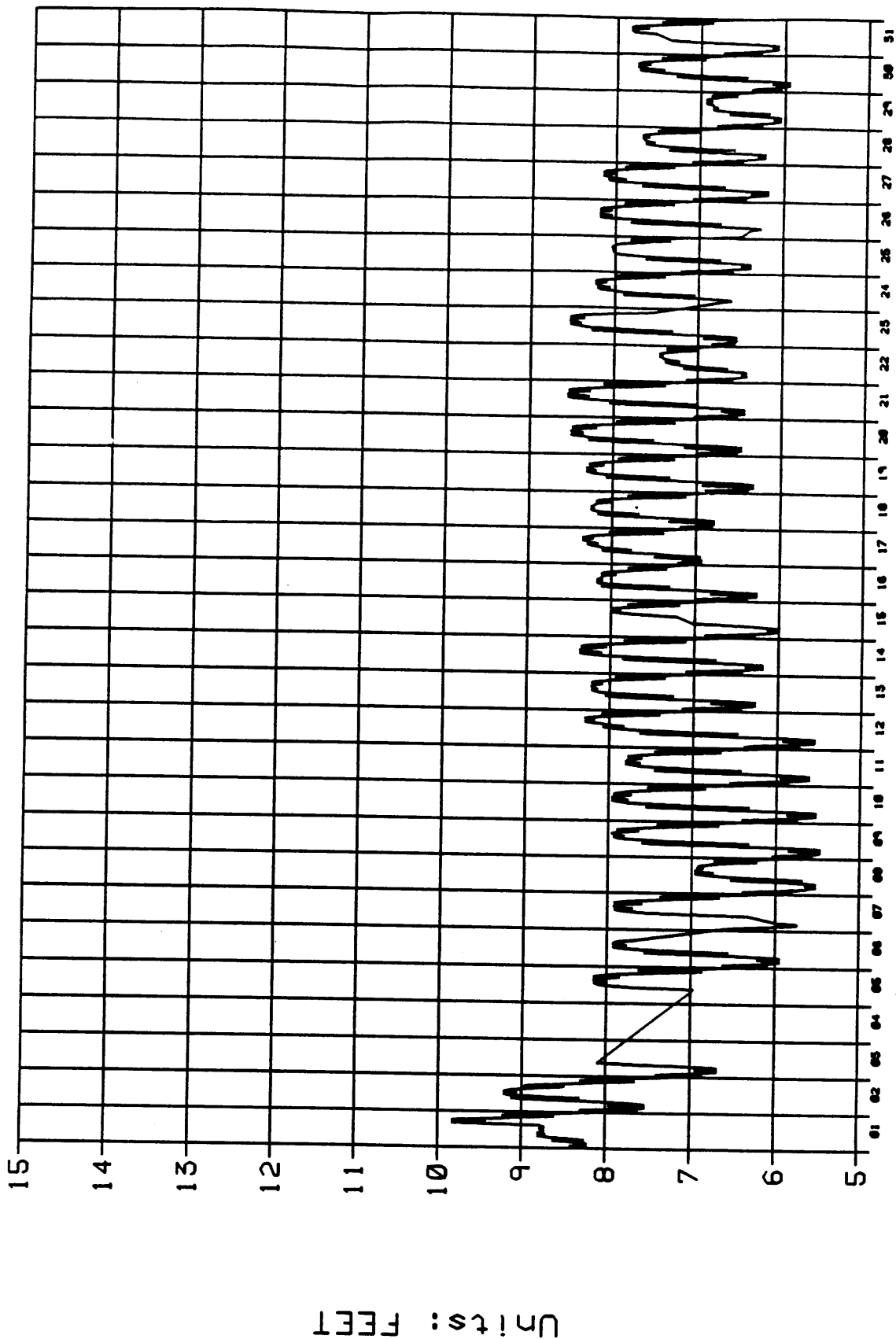
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— GH
Gage Height (feet)

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Plotted 5-APR-93 06:36:04

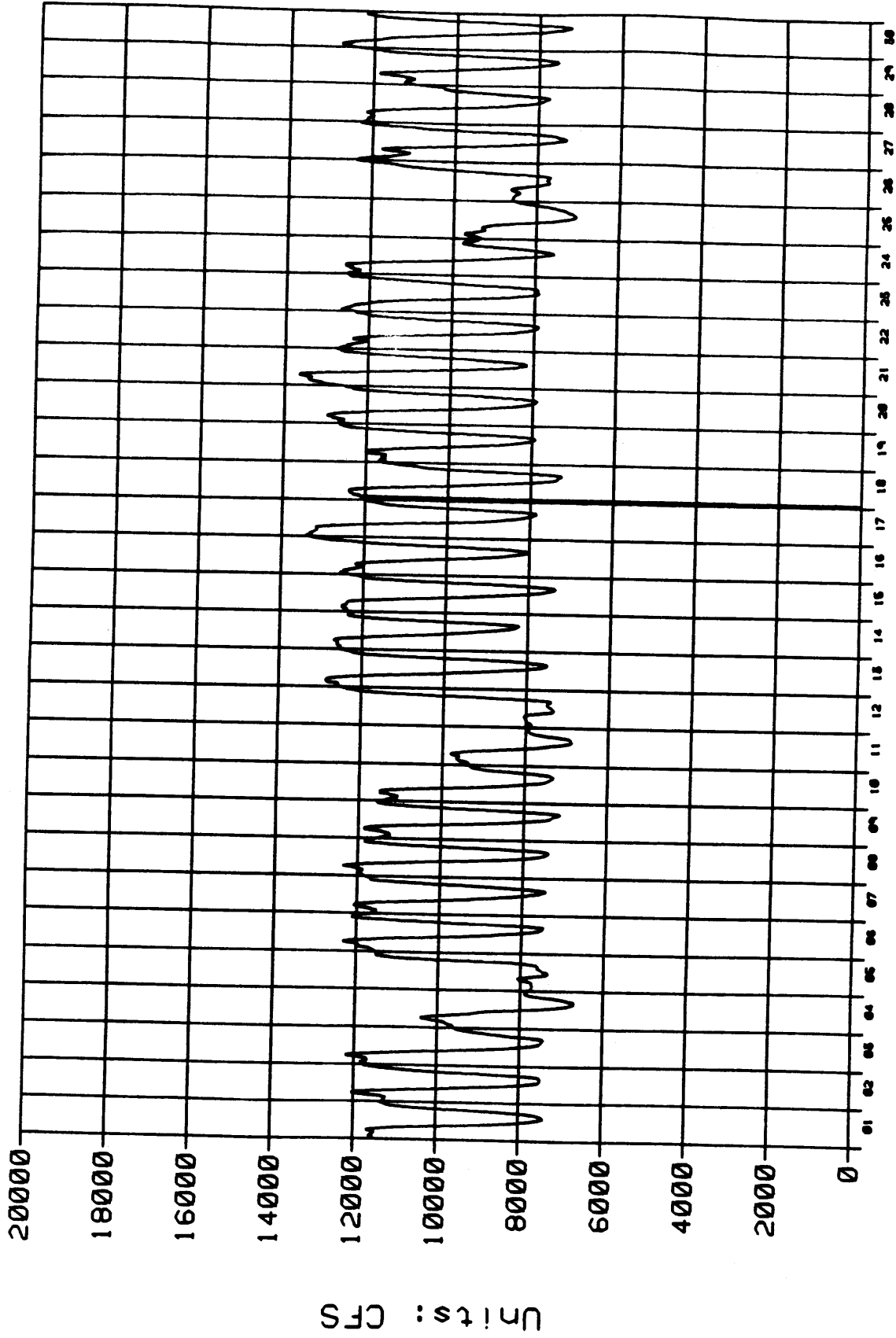


CGCA COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Flow Rate (cfs)

Date From 01-MAR-1993 Through 31-MAR-1993
Plotted 5-APR-93 08:31:41



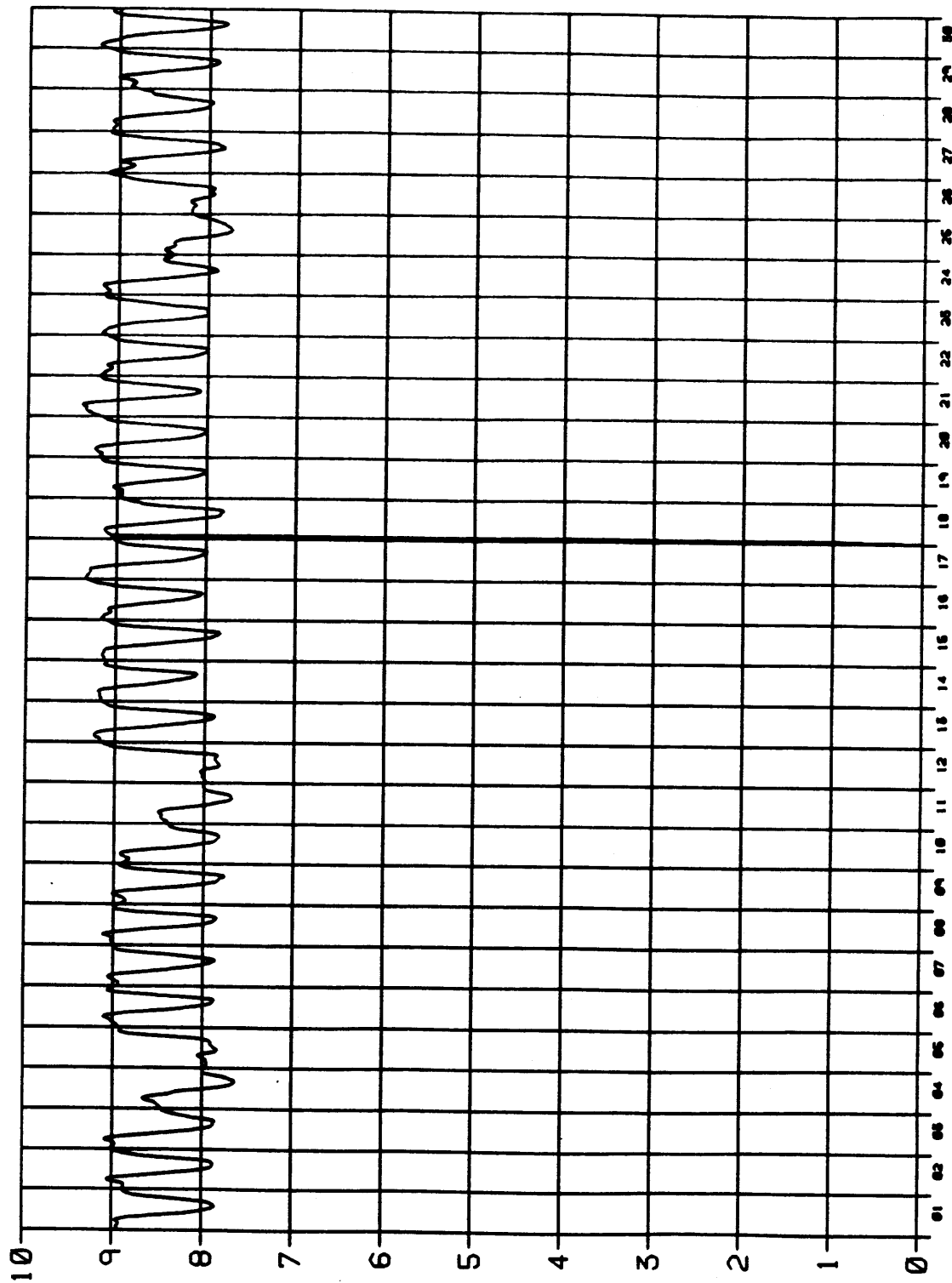
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Plotted 25-MAY-93 11:31:02



CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
Flow Rate (CFS)

Reverse This
Sheet.

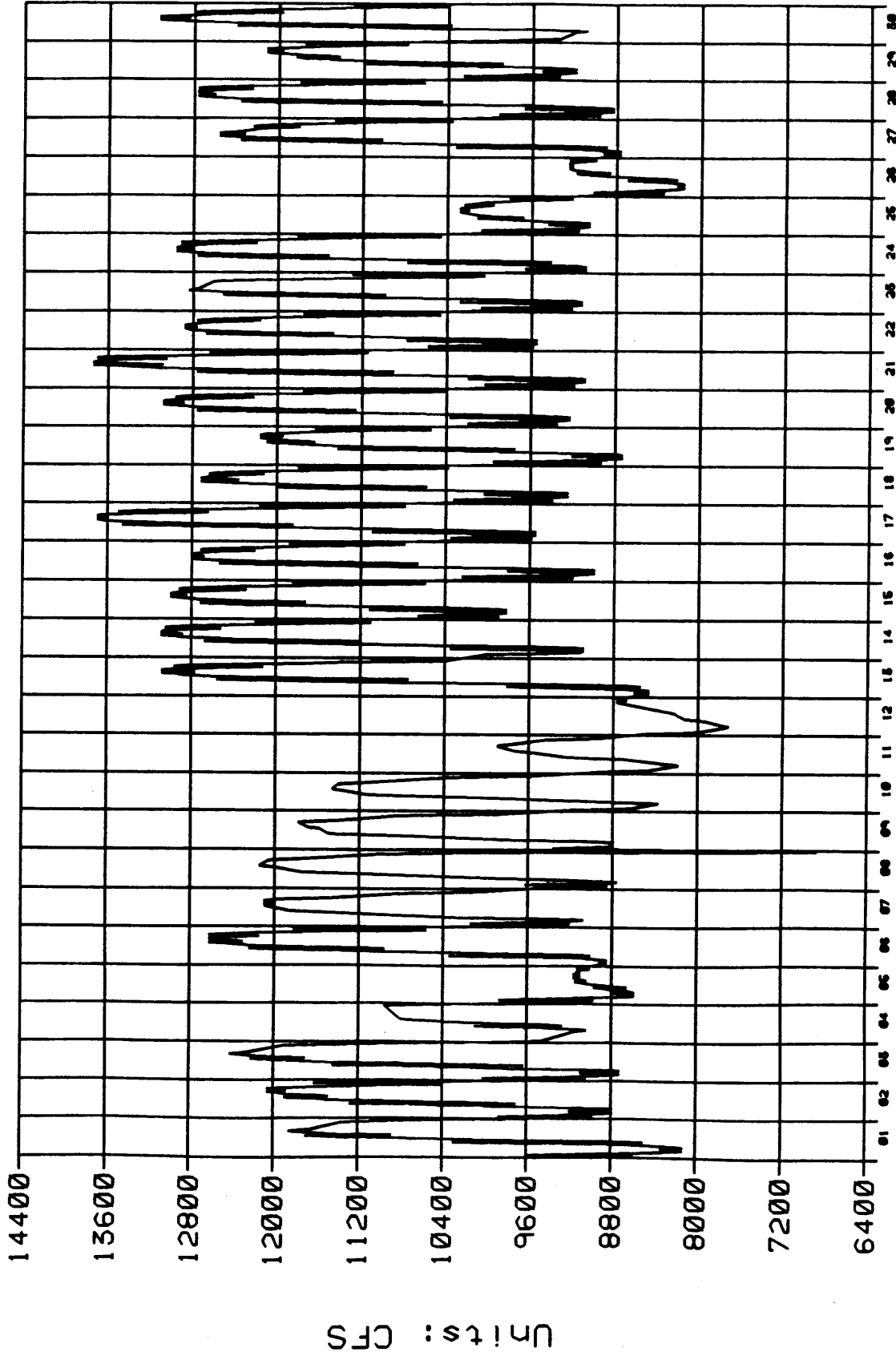
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Units: FEET

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Gage Height (feet)

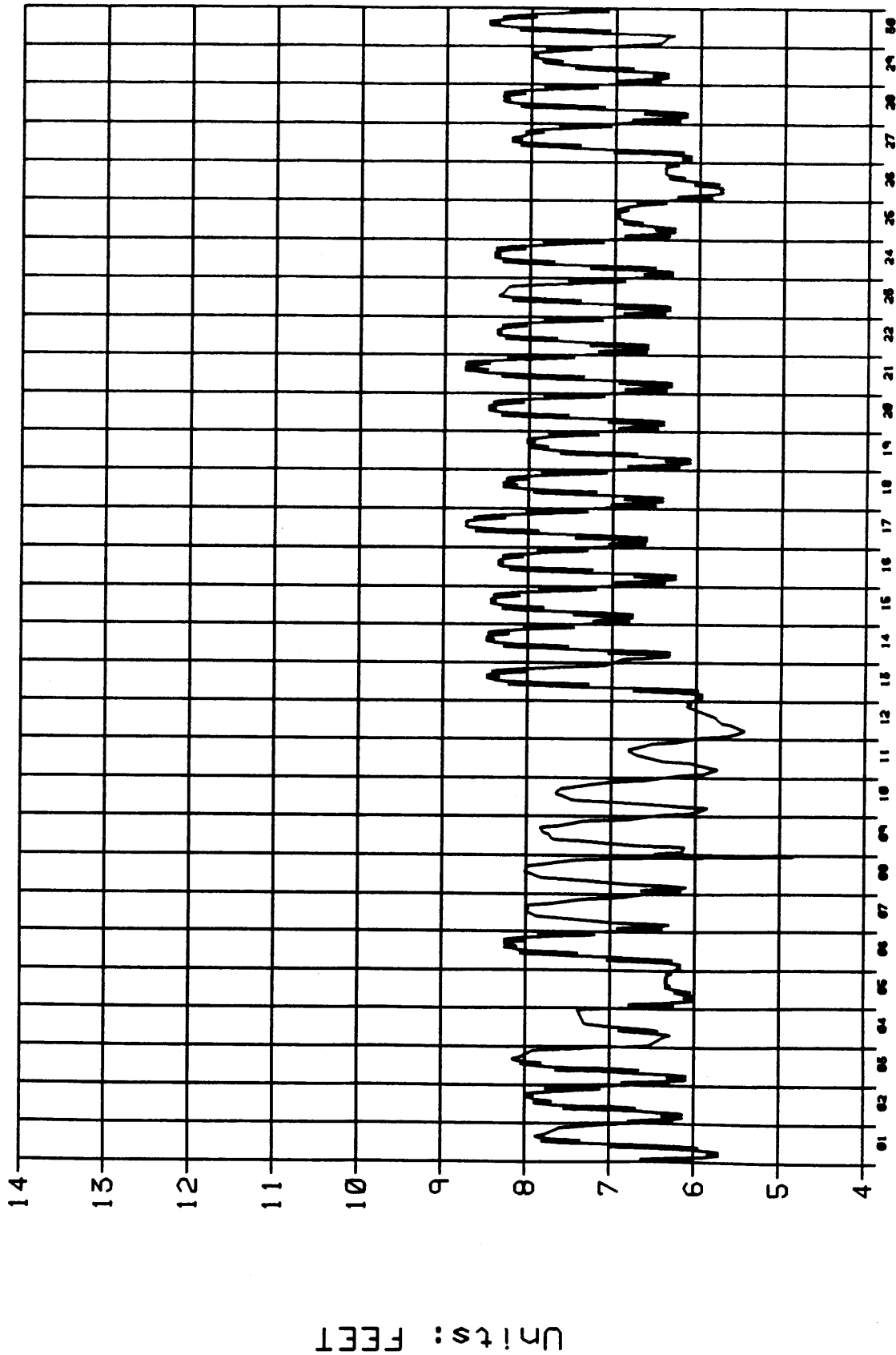
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 Flow Rate (cfs)

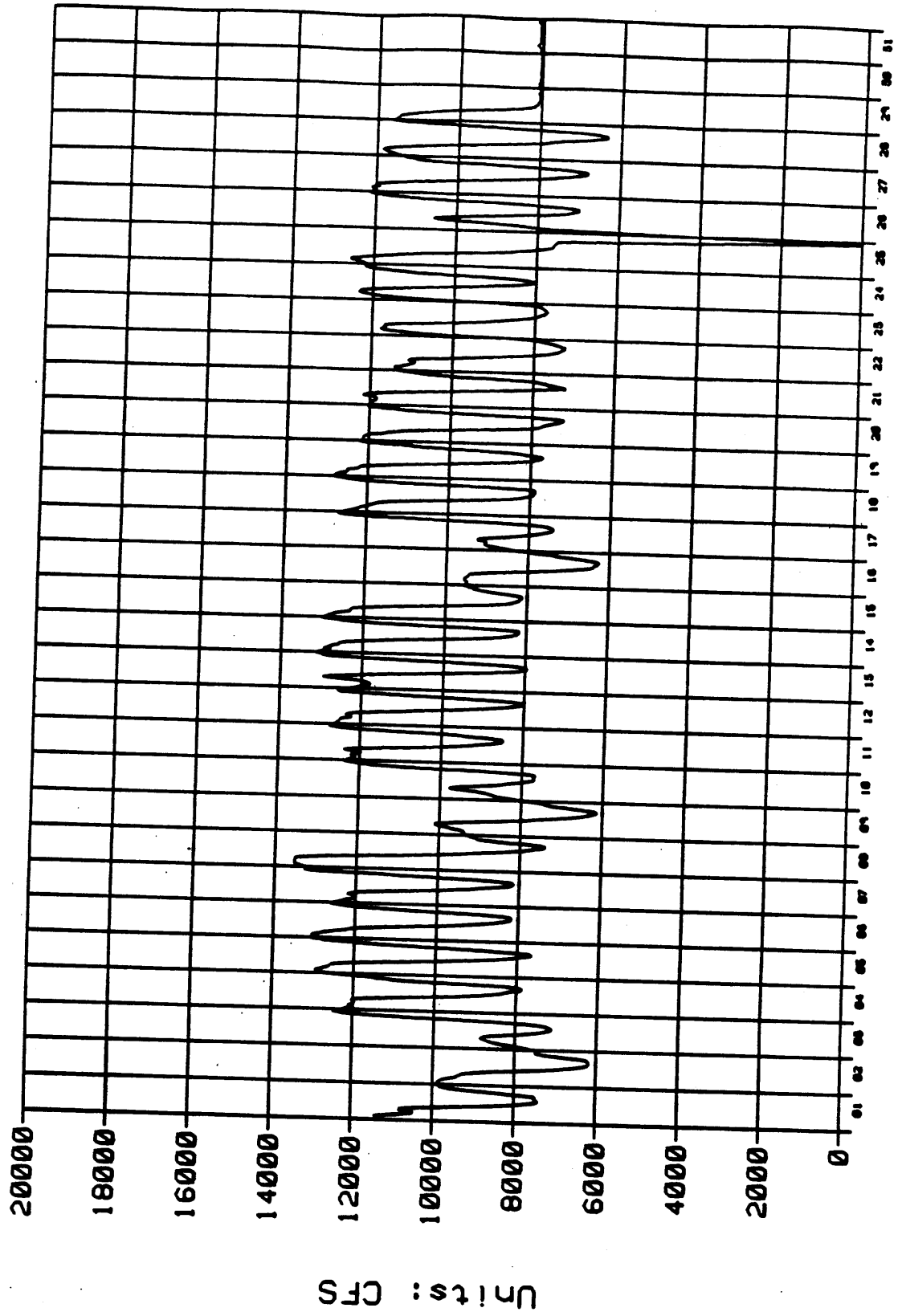
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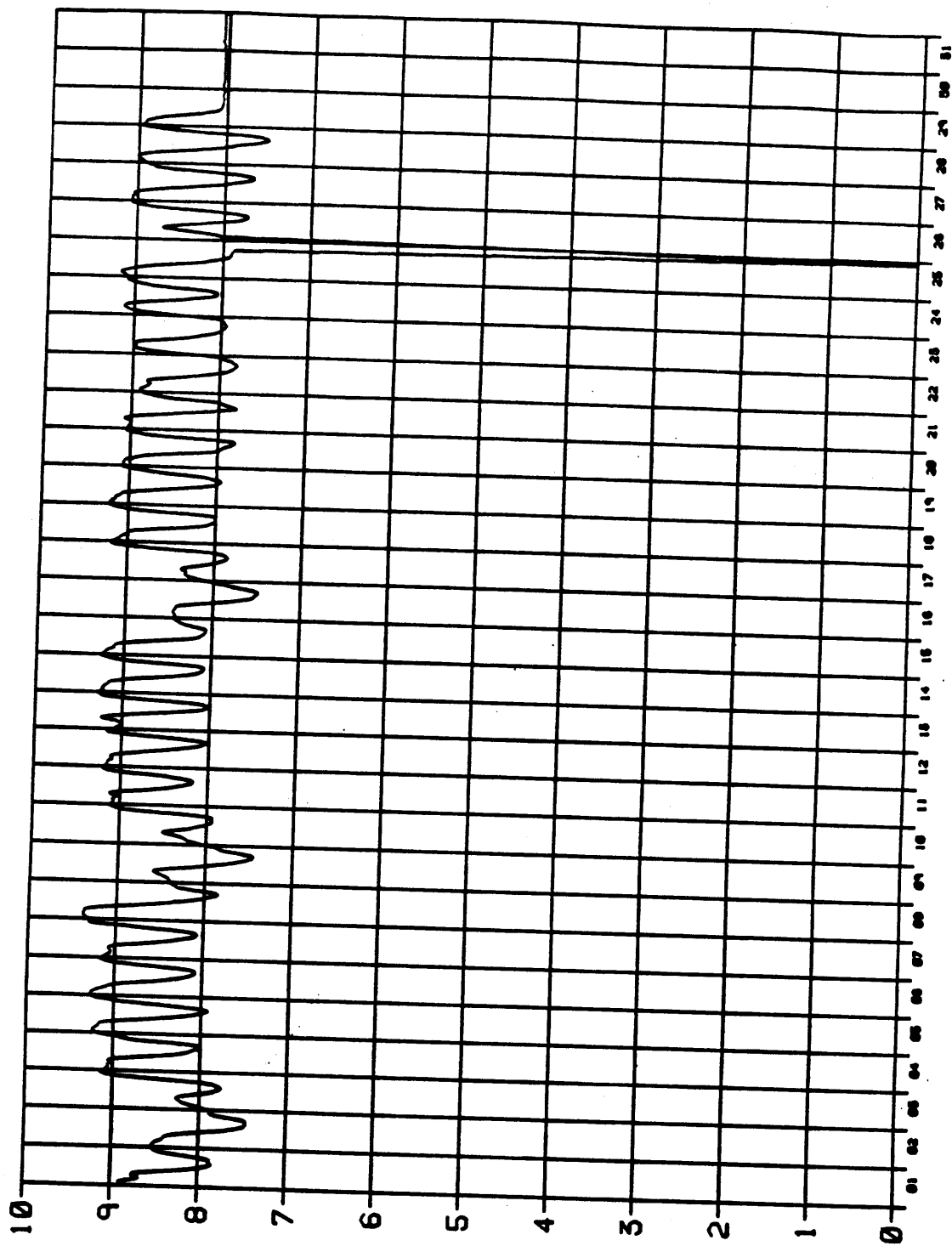
CGCA COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
—— GH Gage Height (feet)

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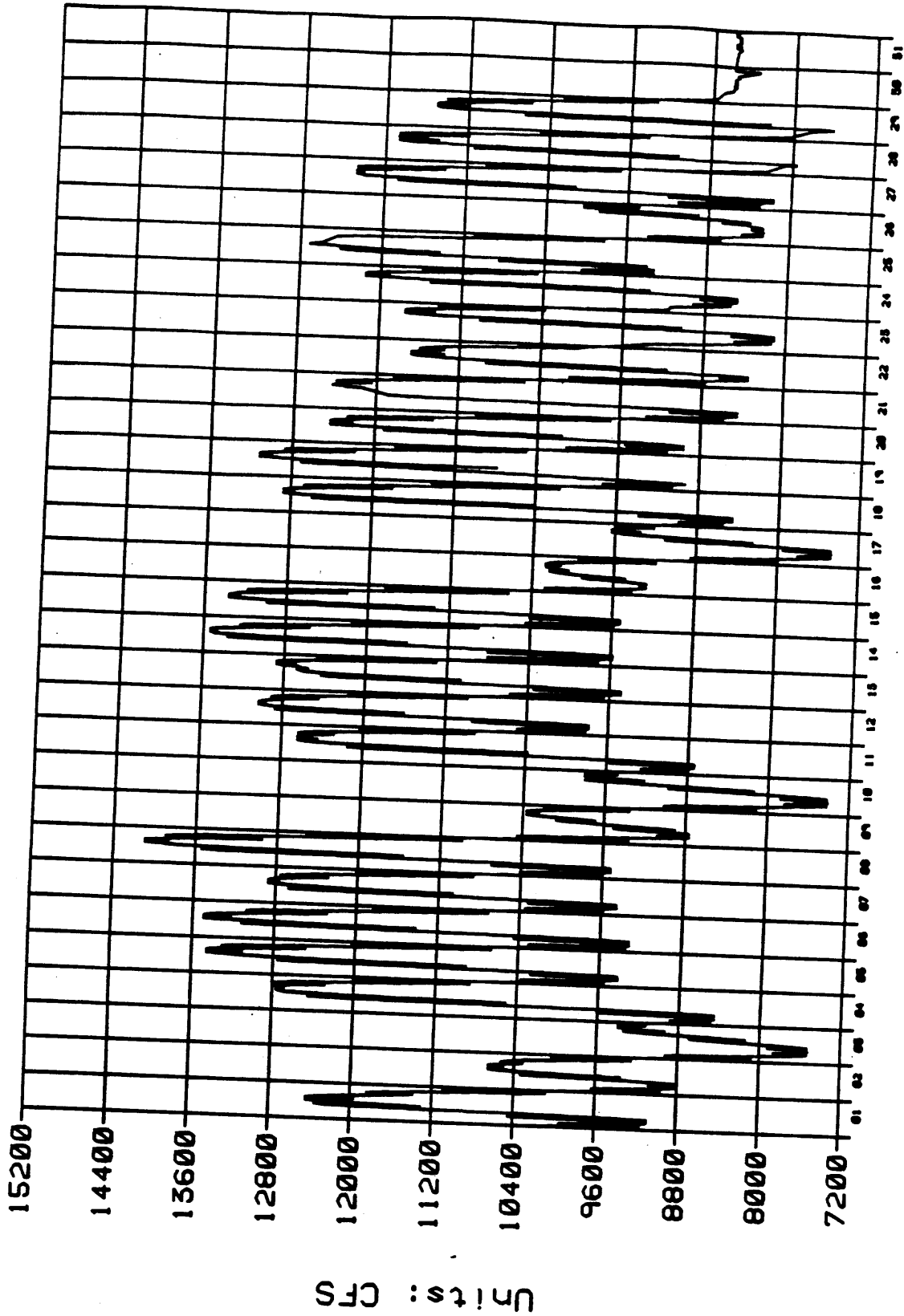
CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
Flow Rate (CFS)

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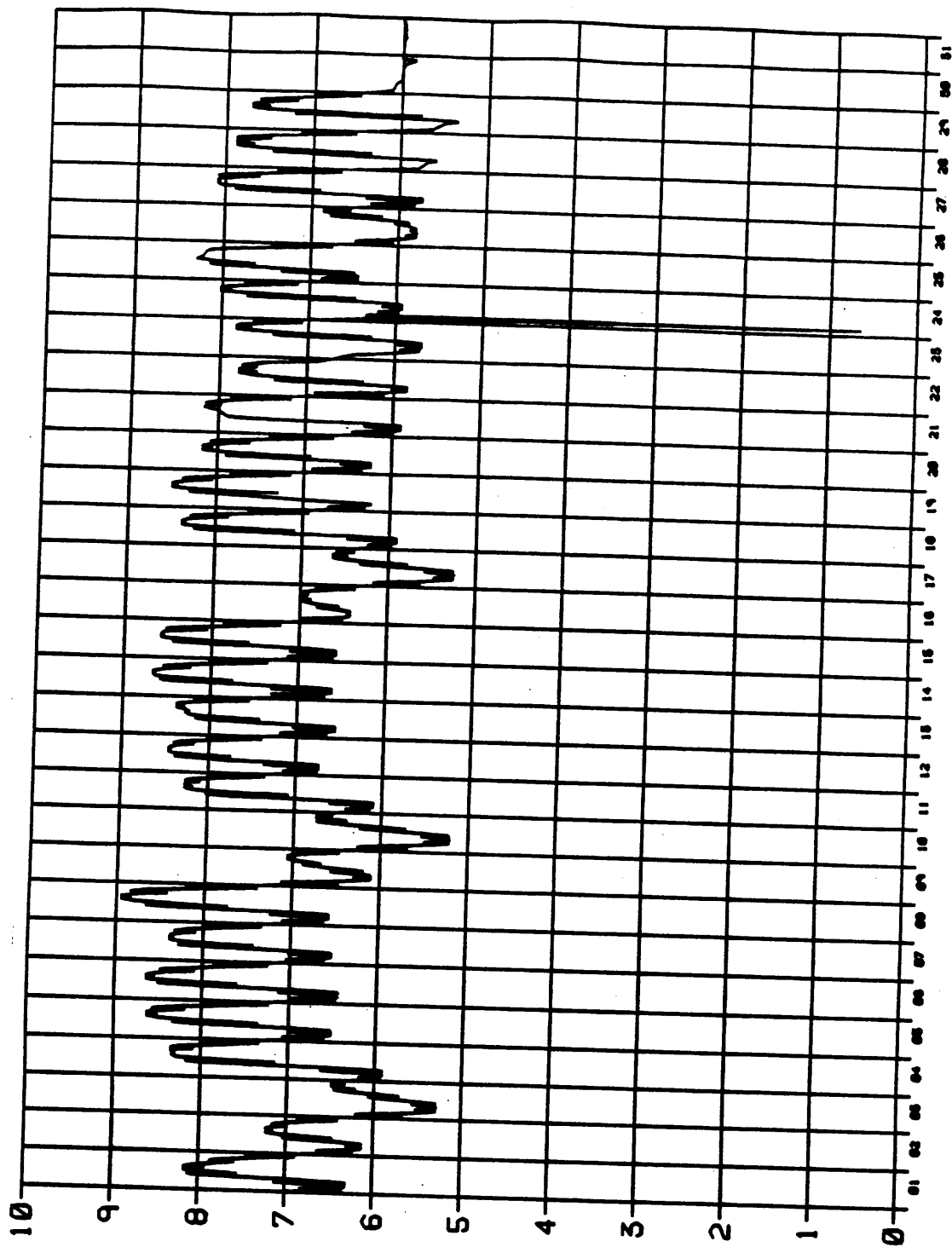
CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
— GH
Gage Height (feet)

Date From 01-MAY-1993 Through 31-MAY-1993
 Plotted 19-AUG-93 11:20:58



CGCA _____ 0 COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
 Flow Rate (cfs)

Date From 01-MAY-1993 Through 31-MAY-1993
Plotted 19-AUG-93 11:22:17



CGCA COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Gage Height (feet)

Attachment C

**Glen Canyon Dam Interim Operations
Western Area Power Administration**

GLEN CANYON DAM INTERIM OPERATIONS

Estimated Net Expense
March, April, and May 1993

August 1993

GLEN CANYON DAM INTERIM OPERATIONS

Estimated Net Expense

March 1993 Through May 1993

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GLEN CANYON DAM INTERIM OPERATIONS

Estimated Net Expense

March 1993 Through May 1993

I. EXECUTIVE SUMMARY

Power Scheduling and Real-Time Operations

- During March (16th-20th) a forced outage of 3,000 MW of capacity (Palo Verde, Bonanza, and Laramie units) went offline forcing Western to purchase energy at 30 mills/KWh.
- In May, due to high water releases, Western was forced to sell offpeak energy for a low of 3 mills/KWh to maintain releases.
- From Saturday, May 29th through Monday, May 31st, (Memorial Day), an aerial photography study at Glen Canyon Dam reduced releases to a 8,000 cfs constant (303 MW).

Analysis of Ramping Events

- There were 82 deviations: "Control Area Regulation" accounted for most of the anomalies.

Expenses

- Net expense of interim releases:

March 1993	\$344,101
April 1993	\$227,469
May 1993	\$311,296

- WY 1991-93 Net Expense Summary

<u>WATER YEAR</u>	<u>Estimated Actual Net Expense</u>
WY 1991	\$1,065,692 ¹
WY 1992	\$4,245,940
WY 1993 (Year-to-date, Oct-May)	\$2,913,498
	<hr/>
(Cumulative Est. Actual Net Expense)	\$8,225,130

¹ August and September 1991 used the previous methodology

- A table of interim release expenses for Water Year (WY) 1992 comparing the previous method with the refined method is presented.

	Total Net Expense
WY 1992	
Previous Method	\$2,757,942
WY 1992	
Refined Method	\$4,245,940

Power Scheduling Concerns (Future)

- It is expected that June will be difficult to schedule due to the high Spring releases from Flaming Gorge and from the Aspinall Units.
- The period from July through September is anticipated to look good for power control operations, because Glen Canyon generation will be high and the Aspinall Unit is expected to be available.

II. INTRODUCTION

On August 1, 1991, former Interior Secretary Manual Lujan implemented interim flows at Glen Canyon Dam. These interim flows were a considerable departure from previous operation of the dam and have had a significant impact on the daily operation of Western Area Power Administration's (Western) Upper Colorado Control Area.

The impacts of this change in dam operations have required Western to implement new scheduling procedures for its customers, develop interim release guidelines for real-time operations, purchase higher-priced energy during onpeak periods, and increase the firm-power rates to its customers to cover the additional costs.

The following sections are a review of Power Operations for the reporting period.

III. SCHEDULING

- A. Interim release restrictions have limited Western's ability to accommodate hourly changes in the preschedules. These restrictions have required Western to request customer prescheduling 3 days in advance in order to match firm loads to available project resources and substitute purchases for any hourly deficits. Hourly changes to preschedules have been restricted by the lack of system flexibility. The burden to adjust to changes in real-time load has shifted from the contractors' use of their SLCAIP resources to the contractors' alternate resources. A majority of these other resources are thermal and have higher costs associated with their use.

B. Power Scheduling and Real-Time Operations

1. Power Scheduling and Purchases for March 1993

March water releases from Glen Canyon totaled 606,000 acre-feet. The weekday generation pattern was pre-scheduled at approximately 6,640 cfs. (235 MW) during offpeak hours ramping up to a maximum of 12,640 cfs. (448 MW) during onpeak hours for a majority of the month. This followed the daily maximum fluctuation restriction of 6,000 cfs. (213 MW). Weekend releases were adjusted downward to follow reduced weekend loads.

The first half of March was uneventful: Weather across the region was mild and energy availability remained constant. All firm energy requirements were supplied from seasonal purchase agreements and the additional generation made available by water releases from the Aspinall Unit around March 12. However, from March 16 through March 20, the power system experienced a severe forced outage of over 3,000 MW of capacity due to Palo Verde, Bonanza, and three Laramie River station units going off line. Out of 300 MW of contracted purchases, Western could only schedule 25 MW due to these unit outages. The remainder of Western's purchase requirements were attained through "multiple" scheduled purchases across the interconnected system, raising releases from the Glen Canyon Dam for a short duration and requiring a special release from Flaming Gorge.

Prices for the supplemental non-firm energy went as high as 30 mills/KWh (scheduled from California) and was very difficult to acquire. Considering the scarcity of energy during this period, a price of 30 mills/KWh was low, according to Montrose Control Power Staff. The Salt Lake City Area (SLCAO) was not only trying to support Western's loads during this time, but also trying to assist the Loveland Area and Bonanza plant owners. The Loveland Area had water constraints; the Bonanza plant went down for maintenance. After the "energy crisis" was ameliorated, the power system resources returned to normal: All contractual purchases became available March 21.

Due to daily fluctuation limitations, increased onpeak hourly generation releases requires an increased offpeak release and greater offpeak generation. Glen Canyon generation was "backed down" to make up for the additional water released during the middle of March. When the weather turned cold, loads did not increase because customers used much of their energy allocations during the March 16-20 period. Prices on the economy energy market remained high: 27.5 mills/KWh onpeak; 18.5 mill/KWh offpeak (Secretary's Report, March 19, 1993). All firming energy was acquired through seasonal and long-term purchase contracts.

2. Power Scheduling and Purchases for April 1993

April water releases from Glen Canyon totaled 595,000 acre-feet. The weekday generation pattern was pre-scheduled at approximately 7,200 cfs (257 MW) during offpeak hours, ramping up to a maximum of 13,200 cfs (472 MW) during onpeak hours for most of the month.

This followed the maximum daily fluctuation limit of 6,000 cfs per day (215 MW). Weekend releases were adjusted (downward) to follow (reduced) weekend loads.

Releases from the Aspinall Unit were increased to maximum generation at Crystal (30 MW) and "full bypass" (for a total of 4,100 cfs with water released through the turbine for 2,100 cfs and through the bypass tubes for 2,000 cfs) towards the end of the month. Scheduling this release created some unwanted offpeak generation at the beginning of the month when a Morrow Point unit went off line.

In April, Flaming Gorge releases were increased enabling generation through high-load periods. The Flaming Gorge releases provided Western with full operational flexibility on the Aspinall Unit, making it possible for Montrose to "back down" firm purchases, ". . . saving Western a few million dollars in purchased power expenses over the course of March through April," according to Montrose Power Control Staff. The economy energy market in April became tight but all deficits were satisfied through seasonal and long term purchase agreements. Prices on the energy market remained steady at 20 mills/KWh (onpeak), to 14 mills/KWh (offpeak) for the first 3 weeks, then jumping to 27 mills/KWh (onpeak) for the last week in April. This tightening in prices was attributed to several unit outages in New Mexico and Arizona (Secretary's Report, April 30, 1993.)

3. Power Scheduling and Purchases for May 1993

Water releases from Glen Canyon powerplant totaled 592,000 acre-feet for May. Daily fluctuation rate was limited to 6,000 cfs; the weekday generation pattern was prescheduled at approximately 7,200 cfs (263 MW) during offpeak hours ramping up to approximately 13,200 cfs (482 MW) during onpeak hours. A daily generation fluctuation limit of 219 MW. Weekend releases were adjusted downward to follow reduced weekend loads.

Releases from Flaming Gorge and the Aspinall Unit were high due to high spring runoff, providing Western with sufficient generating capacity, allowing for reduced onpeak and offpeak purchases.

On May 14, the Flaming Gorge "Spring Endangered Fish Release" commenced, coinciding with peak Spring runoff. Power scheduling from May 14 through the end of the month became very difficult for Montrose. Due to high, regulated river flows on the Green River and the Gunnison River, and unregulated flows on the Yampa River, generation was either curtailed or increased to help alleviate localized flooding. The "real time" generation reductions and fish release coordination problems with the Fish and Wildlife Service (F&WS) at Flaming Gorge created operational problems, resulting in several release deviations at Glen Canyon. Crystal reservoir began spilling on May 20th and continued through the remainder of the month. Aspinall flexibility was reduced with the high flow requirements. Energy prices in May, ranged from (onpeak) 16-22 mills/KWh to (offpeak) 12-15

mills/KWh. Offpeak energy was sold for as low as 3 mills/KWh (forced sales) to maintain releases. Onpeak purchases continued over high-load periods due to release restrictions at Glen Canyon.

a. Special Releases

From Saturday, May 29, through Monday, May 31 (Memorial Day weekend), an aerial photography study at the Glen Canyon Dam reduced releases to an 8,000 cfs constant (303 MW).

4. Future Scheduling Concerns for June 1993 through September 1993

Glen Canyon generation, with the exception of September, will be high and all firm purchase requirements will have been prescheduled. It is anticipated that resources will be tight, but will not create any problems with Western's seasonal and long-term contractual purchase arrangements. The Aspinall Unit should be available, which will allow for system flexibility. Flaming Gorge should be available from August through September. If resources remain reliable and if the Southwest does not experience any "heat waves", it is expected that the system should not face any problems.

5. 1993-94 Winter Season Outlook

Generation capability during the 1993-94 winter season looks very good at this time. Firm purchase requirements will be reduced significantly if the projected release schedule in the Bureau's Annual Operating Plan (AOP) for WY 1994 remains unadjusted. Winter operations at Flaming Gorge must be planned with the F&WS by mid-July.

IV. **ANALYSIS OF RAMPING EVENTS**

A study was made to analyze hourly release rates which appeared to deviate from interim flow criteria. Operational records and logs kept during the study period, March 1, 1993, through May 31, 1993 were reviewed.

The operational records and logs are contained within the packet Glen Canyon Dam Interim Flows—Glen Canyon Power Plant Operations, for March 1993 through May 1993 and provide specific explanations for each ramping event.

Each page within the packet contains (1) a strip chart of real-time Glen Canyon Dam operations during the ramping event, (2) a graph of the USGS Lees Ferry Gauge showing river elevation during the ramping event, (3) a graph of hourly integrated Glen Canyon Dam generation during the ramping event, and (4) a brief written explanation of the ramping event.

For the study period, 82 instances of deviations were found. Most of the conditions were caused by more than one factor: for example, control area regulation and imports/exports different than preschedule;

therefore, multiple variations can be explained by one anomaly. A majority of the deviation for Control Area Regulation is attributed to problems associated with Loveland consolidation in May.

The following table summarizes the causes and frequency of the 51 deviations:

<u>Primary Cause(s) of Deviation</u>	<u>Number Of Instances</u>	<u>Percent Of Events</u>
Control Area Regulation	27/82	33
CRSP Resource Availability	7/82	9
Aspinall Operations	5/82	6
Flaming Gorge Operations	5/82	6
Imports/Exports Different than Preschedule	21/82	26
Glen Canyon Operations	2/82	2
Other	15/82	18

V. Expenses

A. Net Expense

The estimated net expense of interim releases for March, April and May 1993 are summarized below:

	<u>Net Expense</u>
March 1993	\$344,101
April 1993	\$227,469
May 1993	\$311,296

Attached are Tables 1, 2, and 3 detailing the net expense analysis by component for March 1993, April 1993, and May 1993.

B. Purchases

A comparison of Base Case purchases to Actual purchases are summarized below:

Energy Purchase Comparison			
Months	Simulated Base Case Purchases	Actual Purchases	Differences
March 1993	62,664 MWh	52,676 MWh	9,988 MWh
April 1993	58,418 MWh	57,748 MWh	670 MWh
May 1993	35,699 MWh	27,860 MWh	7,839 MWh

For all months (March, April, and May 1993) actual purchases were less than projected for Base Case conditions. This is due to a

shift in deficits from onpeak to offpeak hours in the Base Case, resulting in higher purchases during offpeak hours.

C. Economy Energy Sales (Surplus)

For all months, actual nonfirm energy sales were (also) less than projected for Base Case conditions. Revenues foregone are estimated below:

Energy Sales and Revenues Foregone

<u>Months</u>	<u>Base Case</u>	<u>Actual</u>	<u>Revenues Foregone</u>
March 1993	\$361,145	\$140,332	(\$220,813)
April 1993	61,844	48,263	(13,581)
May 1993	566,384	287,533	(278,851)

D. Average Purchase Prices—Base Case

The average monthly purchase price estimates are derived from the actual nonfirm energy purchase prices. With the help of the Power Control staff (Montrose), some of the higher purchase prices for March that are associated directly with interim release constraints, were excluded. There were no changes in the purchase prices for April and May because it reflected market purchase prices if restrictions were not in place at the Glen Canyon Dam, according to Montrose. An adjusted weighted average of remaining purchase amounts and prices are rendered to calculate the base case offpeak and onpeak purchase prices.

Average Base Case monthly purchase prices are estimated as follows:

Energy Purchase Prices - Base Case

<u>Months</u>	<u>Offpeak</u>	<u>Onpeak</u>
March 1993	\$15.93/MWh	\$23.15/MWh
April 1993	15.69/MWh	22.73/MWh
May 1993	13.08/MWh	19.53/MWh

E. Purchase Price—Actual

Average actual monthly purchase prices from all sources are as follows:

Energy Purchase Prices - Actual

<u>Months</u>	<u>Offpeak</u>	<u>Onpeak</u>
March 1993	\$16.86/MWh	\$23.51/MWh
April 1993	15.69/MWh	22.73/MWh
May 1993	13.08/MWh	19.53/MWh

F. Economy Energy Sales Prices—Base Case

The sales price for the Base Case is determined with the help of the Montrose Power Control Staff (Montrose). The estimate of economy energy sales prices involve three steps:

1. Identification of the range of market prices through review of Montrose District Office Power Control staff's summaries of then-current weekly market prices, as reflected in Western's Weekly Reports to the Secretary.
2. Review of the actual monthly economy energy sales summary and, with the help of the Power Control staff, identification of those forced sales directly associated with interim release constraints.
3. Assumption of expected sales price based on then-current market conditions for that portion of sales identified in step 2.

In most instances, Western would have had the flexibility of making all or most of the nonfirm energy sales during periods when the value is greatest. For March and April, the economy energy sales prices under the Base Case is the same as the actual sales price, reflecting no forced sales within this period. However, for May there is a \$5.85 per MWh difference between Base Case and actual sales prices. This is due to high releases that occurred in May, forcing Western to sell offpeak energy to the market for a low of \$3/MWh, in the last week of May.

Average monthly economy energy sales prices for Base Case conditions are as follows:

Economy Energy Sales Prices - Base Case

<u>Months</u>	<u>Prices</u>
March 1993	\$22.11/MWh
April 1993	20.27/MWh
May 1993	18.20/MWh

G. Economy Energy Sales Prices—Actual

The actual consummated average monthly economy energy sales prices are as follows:

Economy Energy Sales Prices - Actual

<u>Months</u>	<u>Prices</u>
March 1993	\$22.11/MWh
April 1993	20.27/MWh
May 1993	12.35/MWh

Table 1
Glen Canyon Dam Interim Release
for March 1993
Net Expense Analysis

Base Case (Without Interim Release)		Actual (With Interim Release)	
Firm Load & Losses:	460,225 MWh	Firm Load & Losses:	460,225 MWh
GC Generation:	260,667 MWh	GC Generation:	260,668 MWh
Other CRSP/IP Generation:	153,228 MWh	Other CRSP/IP Generation:	153,228 MWh
Total Generation:	413,895 MWh	Total Generation:	413,896 MWh
Purchases:	62,664 MWh	Purchases:	52,676 MWh
Off Peak:	61,194 MWh	Off Peak:	15,981 MWh
On Peak:	1,470 MWh	On Peak:	36,695 MWh
Surplus:	16,334 MWh	Surplus:	6,347 MWh
Off Peak:	1,973 MWh	Off Peak:	2,383 MWh
On Peak:	14,361 MWh	On Peak:	3,964 MWh
Purchase Prices:		Purchase Prices:	
Off Peak:	\$15.93/MWh	Off Peak:	\$16.86/MWh
On Peak:	\$23.15/MWh	On Peak:	\$23.51/MWh
Sales Price:	\$22.11/MWh	Sales Price:	\$22.11/MWh
Purchase Expense:	\$1,008,851	Purchase Expense:	\$1,132,139
Off Peak:	\$ 974,820	Off Peak:	\$ 269,440
On Peak:	\$ 34,031	On Peak:	\$862,699
Surplus Sales:	\$361,145	Surplus Sales:	\$ 140,332
Base Case Expense:	\$647,706	Change Case Expense:	\$ 991,807
Total Net Expense for March 1993		\$344,101	

Table 2
Glen Canyon Dam Interim Release
for April 1993
Net Expense Analysis

Base Case (Without Interim Release)		Actual (With Interim Release)	
Firm Load & Losses:	471,249 MWh	Firm Load & Losses:	471,249 MWh
GC Generation:	259,263 MWh	GC Generation:	259,263 MWh
Other CRSP/IP Generation:	156,619 MWh	Other CRSP/IP Generation:	156,619 MWh
Total Generation:	415,882 MWh	Total Generation:	415,882 MWh
Purchases:	58,418 MWh	Purchases:	57,748 MWh
Off Peak:	44,300 MWh	Off Peak:	11,755 MWh
On Peak:	14,118 MWh	On Peak:	45,993 MWh
Surplus:	3,051 MWh	Surplus:	2,381 MWh
Off Peak:	225 MWh	Off Peak:	1,340 MWh
On Peak:	2,826 MWh	On Peak:	1,041 MWh
Purchase Prices:		Purchase Prices:	
Off Peak:	\$15.69/MWh	Off Peak:	\$15.69/MWh
On Peak:	\$22.73/MWh	On Peak:	\$22.73/MWh
Sales Price:	\$20.27/MWh	Sales Price:	\$20.27/MWh
Purchase Expense:	\$1,015,969	Purchase Expense:	\$1,229,857
Off Peak:	\$695,067	Off Peak:	\$ 184,436
On Peak:	\$320,902	On Peak:	\$1,045,421
Surplus Sales:	\$61,844	Surplus Sales:	\$ 48,263
Base Case Expense:	\$ 954,125	Change Case Expense:	\$1,181,594
Total Net Expense for April 1993		\$227,469	

Table 3
Glen Canyon Dam Interim Release
for May 1993
Net Expense Analysis

Base Case (Without Interim Releases)		Actual (With Interim Release)	
Firm Load & Losses:	476,567 MWh	Firm Load & Losses:	476,567 MWh
GC Generation:	264,604 MWh	GC Generation:	264,605 MWh
Other CRSP/IP Generation:	207,384 MWh	Other CRSP/IP Generation:	207,384 MWh
Total Generation:	471,988 MWh	Total Generation:	471,989 MWh
Purchases:	35,699 MWh	Purchases:	27,860 MWh
Off Peak:	34,114 MWh	Off Peak:	5,348 MWh
On Peak:	1,585 MWh	On Peak:	22,512 MWh
Surplus:	31,120 MWh	Surplus:	23,282 MWh
Off Peak:	3,877 MWh	Off Peak:	13,825 MWh
On Peak:	27,243 MWh	On Peak:	9,457 MWh
Purchase Prices:		Purchase Prices:	
Off Peak:	\$13.08/MWh	Off Peak:	\$13.08/MWh
On Peak:	\$19.53/MWh	On Peak:	\$19.53/MWh
Sales Price:	\$18.20/MWh	Sales Price:	\$12.35/MWh
Purchase Expense:	\$ 477,166	Purchase Expense:	\$ 509,611
Off Peak:	\$ 446,211	Off Peak:	\$ 69,952
On Peak:	\$ 30,955	On Peak:	\$ 439,659
Surplus Sales:	\$ 566,384	Surplus Sales:	\$ 287,533
Base Case Expense:	(\$89,218)	Change Case Expense:	\$ 222,079
Total Net Expense for May 1993		\$311,296	

August 1993

Table 4
Glen Canyon Dam Interim Release
Summary of Estimated Actual Net Expense
Associated With Interim Release

Cumulative

Net Expense \$5,311,632

<u>Month</u>	<u>Estimated Actual Net Expense</u>	<u>Cumulative Estimated Actual Net Expense</u>
October	\$336,662	\$5,648,294
November	\$375,274	\$6,023,568
December	\$471,698	\$6,495,266
January	\$466,684	\$6,961,950
February	\$380,314	\$7,342,264
March	\$344,101	\$7,686,365
April	\$227,469	\$7,913,834
May	\$311,296	\$8,225,130
WY 1993 Net Expense		\$2,913,498